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Developing aMulti Criteria Model for Stochastic IT Portfolio Selection by AHP Method

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Abstract

In the fast growing world of Information Technology, project selection is one of the most important decisions managers have to make. In this paper, the qualitative and quantitative decision criteria for IT project selection are defined and the relative weights are assigned to them, using AHP method. Then, a portfolio of 99 projects is analyzed with a stochastic scenario-based approach and the best projects are selected within the budget scope of the organization. This study has been done in Tebyan institute, the biggest IT company in Iran.

Keywords: Decision Making, Stochastic, IT Portfolio Selection, Multi Criteria Model, Analytical Hierarchy Process, Information Technology;

1. Introduction

Management is a science of making the right decisions with respect to the relationship between the organization resources and its goals. Nowadays, project selection is one of the most important decisions managers have to make. Wrong decisions in project selection have two types of negative effects on the organization: the organization resources are wasted in unsuitable projects, on the other hand, the organization loses the benefit it could have gained by investing on more profitable projects (Martino, 1995).

But how could an organization select the best projects in order to have the maximum influence on the overall goals of the organization? In order to answer this question, it is necessary to develop a sound understanding of Information Technology decision Criteria and find measures to evaluate them. Then, methods for portfolio selection and optimization will be discussed.

In the recent years, the process of decision making does not depend solely on financial criteria and decision-makers are paying more attention to other Criteria such as market share, competitive advantage and future development. Thus, it is crucial to identify these criteria and find suitable measures to evaluate and select the best projects.

This study deals with critical factors determining managers' decision about selecting different projects. In order to categorize and evaluate the determining factors, the ideas and decisions of CEOs and senior managers of Tebyan institute were analyzed in several stages.

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The reminder of this paper is organized as follows: the next section provides a description of the problem; section 3 contains the process of criteria determination. The mathematical models with two approaches are proposed in section 4. A real case study and conclusions are presented in section 5 and 6, respectively.

2. The problem statement

The classic project selection problem is in fact the selection of a portfolio of projects, such that they maximize the total utility for the organization, while not exceeding the resource constraints. This problem is multi-criteria in nature, since there are different and sometimes conflicting parameters that must be simultaneously considered (Gabriel, 2006). On the other hand, the uncertainty and incompleteness of in data makes it more difficult to analyze for the decision-makers (Wang, 2009). Due to the uncertainty in the nature of this problem, stochastic programming approaches are very suitable. In this study, decision Criteria for IT project selection are determined, based on the information from a huge IT company in Iran with more than 30 branches and offices all over the country. Then a stochastic scenario-based optimization model is proposed to select a portfolio of affordable projects from the proposed projects.

3. Decision Criteria Determination

In this research senior managers' decision-making about project selection was studied. For this purpose, the ideas of Tebyan institute managers were analyzed in order to categorize and evaluate the decision Criteria about project selection.

3.1. Delphi Method

In the first stage, all the relevant criteria for Information System project selection, R&D project selection, new product development and other similar projects were gathered through a careful review of the literature. In this stage, a list of 173 quantitative and qualitative criteria for project selection was generated, all of which could be applied to information technology project selection. These criteria were categorized in 6 main groups according to the model proposed by (Jiang J., Klein G., 1999). These main categories are illustrated in Figure 1, which shows the most important decision Criteria in project selection.

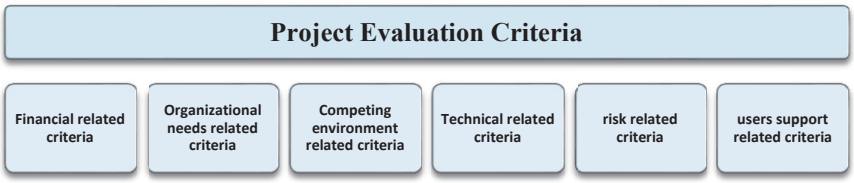


Figure1. Project evaluation criteria

Four rounds of interviews were conducted to evaluate the categories and add new criteria according to the top managers' mindsets. Then, a questionnaire was distributed among them to evaluate the importance of these criteria on a basis of 1 to 10. The average scores were then calculated and decision parameter with average scores less than 3 were omitted and considered as sub-criteria for other parameters. At this stage, the conceptual model for this research was developed and used for the next stage.

3.2. AHP Method

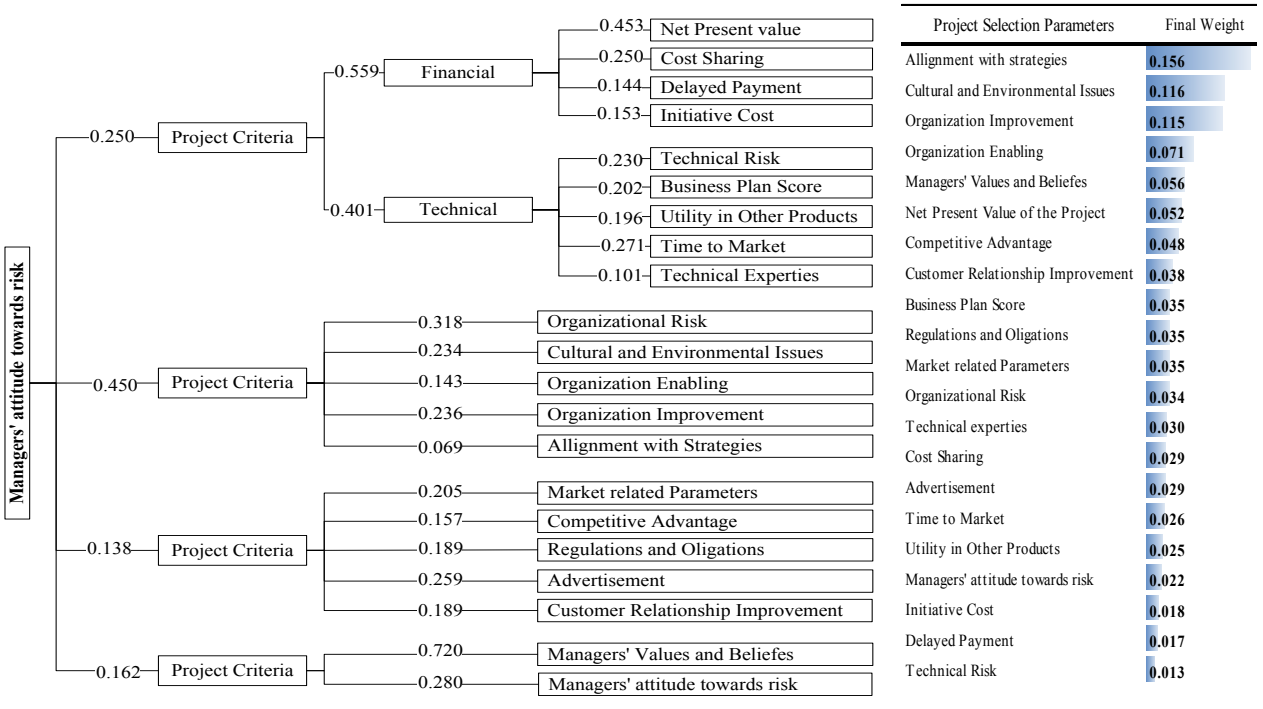
The analytic hierarchy process (AHP) has been employed to guarantee that the assigned weights of each objective are suitable (Saaty, 1990). In this stage, an electronic questionnaire was prepared based on the conceptual model to compare each pair of these criteria and evaluate the importance of them in the managerial decisions. The questionnaire was sent to all senior managers of Tebyan institute.

The AHP has been applied to solve unstructured problems ranging from simple personal decisions to complex IS project selection problems (Alkhalil, 2002).

3.3. Criteria Determination

After the filled questionnaires were gathered and the inconsistency rates were calculated, the answers with inconsistency rate of over 0.3 were omitted and for inconsistency rates between 0.1 and 0.3 revisions were asked for. The reasons for inconsistency were studied and resolved in all cases. The filled questionnaires were given weights according to the characteristics of the responding managers such as the organizational position, working experience, educational level and the inconsistency rate. Inconsistency rate was considered as a measure of the respondents' accuracy of comparison and had a negative effect on the weight of the respondent. This means that answers with higher inconsistency rate had a lower impact on the final model. But the other three factors were considered as positive factors, so that the answers of CEOs with higher education level and more working experience would have a higher weight in the final decision.

Finally, the accumulated model was developed according to the weighted ideas of the experts and the importance rate of each of the criteria was generated according to Figure 2.



a. b.

Fig 2. a) the hierarchy of decision Criteria and relative weights, b) the absolute weights of Criteria

The overall inconsistency rate was 0.034, which is acceptable according to (Saaty, 1990). Thus, the findings of this research were accepted by the managers and can be referred to as a decision-making model for information technology project selection.

4. Project Selection Mathematical Models

In this section, an integer programming model is presented to select a portfolio of projects with respect to the available budget of organization, such that the total weight of selected projects is maximized.

To this end, two states of deterministic and stochastic are considered. For the first state, the expected values of cost (EV) and for the second state 5 scenarios are considered. The results obtained from the two models are compared at the end.

To explain the mathematical model, we begin with introducing the notations, in Table 1.

Table 1. the notations used in the mathematical model

Sets	
i	The number of projects proposed to the organization.
s	The number of scenarios for stochastic cost of the projects.
Parameters	
$w(i)$	The weight of project i.
$p(s)$	The probability of scenario s occurring.
$c(i,s)$	The cost of project i in scenario s.
$Budj$	The available total budget of organization for a planed horizon.
Decision variable	
$x(i,s)$	The binary decision variable, which is 1 if project i is selected in scenario s, and otherwise is zero.

4.1. The Stochastic Model

The scenario-based stochastic model (wait and see approach) is presented below:

$$\textbf{\textit{Maximize}} \quad Z = \sum_{s=1}^{S}\sum_{i=1}^{N} p(s).w(i).x(i,s)$$

$$\textbf{\textit{Subject to:}} \quad \sum_{i=1}^{N} c(i,s).x(i,s) \le Budg \qquad s = \{1,2,\dots,S\}$$

$$x(i,s)\epsilon\{0,1\} \qquad i = \{1,2,\dots,N\}, \qquad s = \{1,2,\dots,S\}$$

4.2. The Deterministic Model

The deterministic model with expected values of cost is as follows:

$$\textbf{\textit{Maximize}} \quad Z = \sum_{i=1}^{N} w(i).x(i)$$

$$\textbf{\textit{Subject to:}} \quad \sum_{i=1}^{N} c(i).x(i) \le Budg$$

$$x(i)\epsilon\{0,1\} \qquad i = \{1,2,\dots,N\}$$

5. Numerical Results

The data for 99 proposed projects to the case study organization were gathered, and the best policies for the organization were suggested by the two models. Table 2 and Table 3 show a sample of the outputs of the models.

Table2. Results of stochastic model

	project1					project2					...	Project99					Total Utility
scenario	sc1	sc2	sc3	sc4	sc5	sc1	sc2	sc3	sc4	sc5	...	sc1	sc2	sc3	sc4	sc5	4180
x(i,s)	1	1	1	0	0	1	1	1	1	1	...	0	0	0	0	0	

The policy of the stochastic model is based on scenarios, e.g. if scenario 1 occurs , projects 1 and 2 will both be selected, while at the occurrence of scenario 4 project 1 will not be selected.

Table3. Results of deterministic model

	Project1	Project 2	Project 3	Project 4	Project 5	Project 6	Project 7	...	Project99	Total Utility
x(i,s)	1	1	1	0	0	1	0	...	0	4141

The policy of the deterministic model is unique. That is, the model does not distinguish the scenario that actually has happened. Instead, it considers an average situation between all possible states.

6. Findings and Conclusions

This paper investigates the process of decision making about project selection in an IT organization. Since the criteria in project selection are a combination of quantitative and qualitative criteria, AHP method was used to determine their level of importance and find a measure to select them. Then a mathematical model, with two approaches of deterministic (EV) and stochastic, was proposed to solve this problem by considering the organization budget constraint. Since the nature of projects is stochastic, and there are different scenarios which might occur, the scenario-based stochastic model is preferred, because it helps the decision-maker to adopt a better policy in different situations.

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